

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently amended) A method of removing ~~contaminants~~ oxygen and water from a hydride or a reactive gas stream comprising contacting said contaminated gas stream with a purifier material for a period of time sufficient to reduce the level of said contaminants to parts-per-billion levels, said purifier material ~~comprising~~ consisting essentially of a nonreactive substrate having a surface and deposited thereon a thin layer of one or more reduced forms of ~~a metal oxide~~ an oxide of one or more metals deposited on said substrate surface.
2. (Original) The method of claim 1, wherein the oxidation state of said metal of said purifier thin layer is lower than the maximum oxidation state of said metal.
3. (Currently amended) The method of claim 2, wherein ~~thin layer of said purifier material further contains~~ reduced form of said metal oxide includes said metal in a zero oxidation state.
4. (Original) The method of claim 1, wherein said metal oxide is selected from the group consisting of oxides of vanadium, molybdenum, antimony, bismuth, tin, cerium, chromium, cobalt, copper, tungsten, and mixtures thereof.
5. (Original) The method of claim 1, wherein said substrate is selected from the group consisting of alumina, amorphous silica-alumina, silica (SiO_2), aluminosilicate molecular sieves, titania (TiO_2) and zirconia (ZrO_2).
6. (Original) The method of claim 1, wherein said hydride gas is selected from the group consisting of ammonia (NH_3), arsine (AsH_3), phosphine (PH_3), germane (GeH_4), silane (SiH_4), methyl silane, t-butyl arsine, t-butyl phosphine, and alkyl and halide derivatives thereof.
7. (Original) The method of claim 1, wherein said reactive gas is selected from the group consisting of trimethyl aluminum, trimethyl gallium, and trimethyl indium.
8. Currently cancelled.
9. (Currently amended) The method of claim 1, wherein said purifier material is prepared by the method comprising:

(a) providing a precursor comprising a nonreactive substrate having deposited thereon a surface and a thin layer of a metal one or more metals of a first oxidation state deposited on said substrate surface;

(b) heating said precursor under a flow of nitrogen at a temperature between about 100°C and 600°C for a period of time; and

(c) treating said precursor from step (b) under reductive conditions sufficient to reduce the oxidation state of said metal of said precursor thin layer, thereby producing said purifier material, wherein the metal of the purifier thin layer has a second oxidation state that is lower than said first oxidation state.

10. (Currently amended) The method of claim 9, wherein said metal of a first oxidation state is selected from the group consisting of an oxide, a salt, an acid, an organic complex, ~~or and~~ an inorganic complex of said metal.

11. (Currently amended) The method of claim 9, wherein said precursor thin layer is deposited on said substrate surface by a method selected from the group consisting of incipient wetness impregnation, ion exchange methods, vapor deposition, spraying of reagent solutions, co-precipitation, and physical mixing.

12. (Currently amended) The method of claim 9, wherein step (c) comprises heating said precursor is heated from step (b) under a flow of a gaseous mixture comprising 100% ammonia at a sufficient temperature for a time sufficient to produce said purifier material nitrogen for about 1 to 200 hours.

13. (Currently amended) The method of claim 9, wherein step (c) comprises heating said precursor is heated from step (b) under a flow of a gaseous mixture comprising from about 0.1% up to 100% hydrogen, the remainder of said mixture comprising a gas selected from the group consisting of an inert gas, a nonreactive gas and a reactive gas for about 1 to 200 hours.

14. (Original) The method of claim 1, wherein the total surface area of said thin layer of said purifier material is less than 100 m²/g.

15. (Original) The method of claim 14, wherein total surface area of said thin layer of said purifier material is between about 10 and 95 m²/g.

16. (Original) The method of claim 1, wherein said purifier material comprises between about 1 to 20% of said reduced forms of said metal oxide and about 80-99% of said substrate.

17. (Currently amended) A method of removing contaminants from a hydride gas stream comprising contacting said contaminated gas stream with a purifier material for a period of time sufficient to reduce the level of said contaminants to parts-per-billion levels, said purifier material comprising a nonreactive substrate having deposited thereon a surface and a thin layer of one or more reduced forms of an oxide of a metal one or more metals deposited on said surface, said thin layer having a total surface area less than 100 m²/g.
18. (Original) The method of claim 17, wherein total surface area of said thin layer of said purifier material is between about 10 and 95 m²/g.
19. (Original) The method of claim 17, wherein the oxidation state of said metal of said purifier thin layer is lower than the maximum oxidation state of said metal.
20. (Currently amended) The method of claim 19, wherein ~~said thin layer of said purifier material further contains reduced form of said metal oxide includes~~ said metal in a zero oxidation state.
21. (Currently amended) A method of removing contaminants from a hydride gas stream comprising contacting said contaminated gas stream with a purifier material for a period of time sufficient to reduce the level of said contaminants to parts-per-billion levels, said purifier material ~~comprising~~ consisting essentially of a nonreactive substrate having deposited thereon a surface and a thin layer of one or more reduced forms of an oxide of a metal one or more metals deposited on said substrate surface, said metals selected from the group consisting of vanadium, molybdenum, antimony, bismuth, tin, cerium, chromium, cobalt, tungsten, and mixtures thereof, wherein the oxidation state of said metal in said purifier thin layer is lower than the maximum oxidation state of said metal.
22. (Currently amended) The method of claim 21, wherein ~~said thin layer of said purifier material further contains reduced form of said metal oxide includes~~ said metal in a zero oxidation state.
23. (Original) The method of claim 21, wherein the total surface area of said thin layer of said purifier material is less than 100 m²/g.
24. (Original) The method of claim 23, wherein total surface area of said thin layer of said purifier material is between about 10 and 95 m²/g.
25. (Currently amended) A method of preparing a purifier material for removing contaminants from a hydride gas stream, said method comprising:

(a) providing a coated precursor comprising consisting essentially of a nonreactive substrate having a surface and deposited thereon a thin layer of a metal one or more metals of a first oxidation state deposited on the substrate surface;

(b) heating said precursor under a flow of nitrogen at a temperature between about 100°C and 600°C for a period of time; and

(c) treating said precursor from step (b) under reductive conditions sufficient to produce said purifier material comprising consisting essentially of said nonreactive substrate having deposited thereon a surface and a thin layer of one or more reduced forms of an oxide of said metal one or more metals of a second oxidation state deposited on said surface, wherein said second oxidation state is lower than said first oxidation state.

26. (Original) The method of claim 25, wherein step (c) comprises heating said precursor from step (b) under a flow of 100% hydrogen at a temperature between about 300°C and 600°C for between about 1 and 200 hours.

27. (Original) The method of claim 25, wherein step (c) comprises heating said precursor from step (b) under a flow of a gaseous mixture comprising from about 0.1% up to 100% hydrogen, the remainder of said mixture comprising a gas selected from the group consisting of an inert gas, a nonreactive gas, and a reactive gas.

28. (Original) The method of claim 25, wherein step (c) comprises heating said precursor from step (b) under a flow of a gaseous mixture comprising 100% ammonia at a sufficient temperature for a time sufficient to produce said purifier material.

29. (Original) The method of claim 25, wherein step (c) comprises heating said precursor from step (b) under a flow of a gaseous mixture comprising from about 0.1% up to 100% ammonia, the remainder of said mixture comprising a gas selected from the group consisting of an inert gas, a nonreactive gas, and hydrogen.

30. (Original) The method of claim 25, wherein step (c) comprises contacting said precursor from step (b) with a reducing agent.

31. (Currently amended) The method of claim 30, wherein said reducing agent is selected from the group consisting of hydrazine, a hydrazine derivative, and lithium aluminum hydride.

32. (Original) The method of claim 25, wherein the oxidation state of said metal in said purifier thin layer is lower than the maximum oxidation state of said metal.

33. (Currently amended) The method of claim 32, wherein said ~~thin layer further comprises reduced form of said metal oxide includes~~ said metal in a zero oxidation state.

34. (Currently amended) The method of claim 25, wherein said ~~metal is one or more metals are~~ selected from the group consisting of vanadium, molybdenum, antimony, bismuth, tin, cerium, chromium, cobalt, copper, tungsten, and mixtures thereof.

35. (Original) The method of claim 25, wherein said substrate is selected from the group consisting of alumina, amorphous silica-alumina, silica (SiO_2), aluminosilicate molecular sieves, titania (TiO_2) and zirconia (ZrO_2).

36. (Original) The method of claim 25, wherein said hydride gas is selected from the group consisting of ammonia (NH_3), arsine (AsH_3), phosphine (PH_3), germane (GeH_4), silane (SiH_4), methyl silane, t-butyl arsine, t-butyl phosphine, and alkyl and halide derivatives thereof.

37. (Original) The method of claim 25, wherein said contaminants are selected from the group consisting of oxygen and moisture.

38. (Original) The method of claim 25, wherein the total surface area of said thin layer of said purifier material is less than $100 \text{ m}^2/\text{g}$.

39. (Original) The method of claim 38, wherein total surface area of said thin layer of said purifier material is between about 10 and $95 \text{ m}^2/\text{g}$.

40. (Original) The method of claim 25, wherein said purifier material comprises between about 1 to 20% of said reduced forms of said metal oxide and about 80-99% of said substrate.

41. (Currently amended) A purifier material prepared by the method of claim 25 and comprising a nonreactive substrate having a surface and a thin layer of one or more reduced forms of an oxide of one or more metals deposited on said surface, wherein the total surface area of said thin layer of said purifier material is less than $100 \text{ m}^2/\text{g}$.

42. Currently cancelled

43. (Currently amended) The purifier material of claim [[42]] 41, wherein total surface area of said thin layer of said purifier material is between about 10 and $95 \text{ m}^2/\text{g}$.

44. (Original) The purifier material of claim 41, wherein the oxidation state of said metal of said purifier thin layer is lower than the maximum oxidation state of said metal.

45. (Currently amended) The purifier material of claim [[44]] 41, wherein said thin layer further contains said metal in a zero oxidation state.

46. (Original) The purifier material of claim 41, wherein said purifier material is regenerable.

47. (Currently amended) A purifier material for removing contaminants from a hydride gas stream, said purifier material comprising a nonreactive substrate having ~~deposited thereon a surface and a thin layer of one or more~~ reduced forms of an oxide of ~~said metal~~ one or more metals deposited on said substrate surface, wherein said metal is selected from the group consisting of vanadium, molybdenum, antimony, bismuth, tin, cerium, chromium, cobalt, tungsten, and mixtures thereof.

48. (Original) The purifier material of claim 47, wherein the total surface area of said thin layer of said purifier is less than 100 m²/g.

49. (Currently amended) The purifier material of claim 48, wherein the total surface area of said thin layer of said purifier material is between about 10 and 95 m²/g.

50. (Original) The purifier material of claim 47, wherein the oxidation state of said metal in said purifier thin layer is lower than the maximum oxidation state of said metal.

51. (Original) The purifier material of claim 50, wherein said thin layer further contains said metal in a zero oxidation state.

52. Currently cancelled

53. (Original) The purifier material of claim 47, wherein said substrate is selected from the group consisting of alumina, amorphous silica-alumina, silica (SiO₂), aluminosilicate molecular sieves, titania (TiO₂) and zirconia (ZrO₂).

54. (Original) The purifier material of claim 47, wherein said purifier material is regenerable.

55. (Currently amended) A purifier material for removing contaminants from a hydride gas stream, said purifier material comprising a nonreactive substrate having ~~deposited thereon a surface and a thin layer of one or more~~ reduced forms of an oxide of ~~said metal~~ one or more metals deposited on said surface, wherein the total surface area of said thin layer is less than 100 m²/g.

56. (Original) The purifier material of claim 55, wherein total surface area of said thin layer of said purifier material is between about 10 and 95 m²/g.

57. (Original) The purifier material of claim 55, wherein the oxidation state of said metal of said purifier thin layer is lower than the maximum oxidation state of said metal.

58. (Original) The purifier material of claim 57, wherein said thin layer further comprises said metal in a zero oxidation state.

59. (Currently amended) The purifier material of claim 55, wherein said ~~metal is one or more metals are~~ selected from the group consisting of vanadium, molybdenum, antimony, bismuth, tin, cerium, chromium, cobalt, copper, tungsten, and mixtures thereof.

60. (Original) The purifier material of claim 55, wherein said substrate is selected from the group consisting of alumina, amorphous silica-alumina, silica (SiO_2), aluminosilicate molecular sieves, titania (TiO_2) and zirconia (ZrO_2).

61. (Currently amended) A purifier material for removing contaminants from a hydride gas stream, said purifier material comprising a nonreactive substrate having ~~deposited thereon a surface and~~ a thin layer of one or more reduced forms of an oxide of ~~said metal~~ one or more metals ~~deposited on said surface~~, wherein the oxidation state of ~~said metal~~ of said purifier thin layer is lower than the maximum oxidation state of ~~said metal~~ one or more metals and the total surface area of said thin layer is less than 100 m^2/g .

62. (Original) The purifier material of claim 61, wherein said thin layer further comprises ~~said metal~~ in a zero oxidation state.

63. Currently cancelled

64. (Original) The purifier material of claim 61, wherein total surface area of said thin layer of said purifier material is between about 10 and 95 m^2/g .

65. (Currently amended) A purifier material for removing contaminants from a hydride gas stream, said purifier material comprising a nonreactive substrate having ~~deposited thereon a surface and~~ a thin layer of reduced forms of an oxide of ~~said metal~~ one or more metals ~~deposited on said surface~~, wherein the total surface area of said thin layer is less than 100 m^2/g and wherein the oxidation state of ~~said metal~~ one or more metals is lower than the maximum oxidation state of ~~said metal~~, wherein ~~said metal~~ is selected from the group consisting of vanadium, molybdenum, antimony, bismuth, tin, cerium, chromium, cobalt, copper, tungsten, and mixtures thereof.

66. (Currently amended) A method of preparing a purifier material for removing contaminants from a hydride gas stream, said method comprising:

(a) providing a precursor ~~comprising~~ consisting essentially of a nonreactive substrate having ~~a surface and deposited thereon~~ a thin layer of a first form ~~a metal of~~ one or more metals ~~deposited on said substrate surface~~, wherein said first form is other than a metal oxide;

(b) heating said precursor under a flow of nitrogen at a temperature between about 100°C and 600°C for a period of time; and

(c) treating said precursor from step (b) under conditions sufficient to convert said first form of said ~~metal~~ one or more metals to an oxide of said ~~metal~~ one or more metals, thereby producing a purifier material comprising consisting essentially of a nonreactive substrate having a thin layer of a ~~metal oxide~~ an oxide of said one or more metals deposited said substrate surface thereon, wherein the oxidation state of said metal oxide is the same as the oxidation state of said first form of said metal, and wherein the oxidation state of said metal of said purifier thin layer is lower than the maximum oxidation state of said metal.

67. (New) The method of claim 9, wherein step (c) comprises heating said precursor under a flow of 100% hydrogen at a temperature between about 300 °C and 600 °C for between about 1 and 200 hours.